LA-UR-21-21095
Approved for public release; distribution is unlimited.

Title: Radiochemistry and Trinity

Author(s): Meade, Roger Allen
Selby, Hugh D.

Intended for: Contribution to NSRC book on weapon testing.

Issued: 2021-02-07

Radiochemistry and Trinity

R.A. Meade
H.D. Selby

Forty seconds after Trinity detonated, Noble Laureate Enrico Fermi calculated the bomb's energy release. By measuring the lateral dispersion of small pieces of paper dropped before, during, and after the blast wave passed him, he calculated an explosive yield of ten kilotons. Although Fermi's estimate was only half of the official yield, it provided immediate confirmation that nuclear fission could be fashioned into a weapon of war.[1]

Although, a large number of experiments were conducted to measure heat, light, neutrons, and gamma rays, the most important experiment was that of accurately calculating the bomb's efficiency and yield – a totally new science created and pioneered by the Los Alamos Radiochemistry Group, which had been created for the express purpose of determining the efficiency of Trinity "through measurements of residual plutonium fuel and fission fragments. The ratio of these two classes of detonation products is proportional to the efficiency of the plutonium" and is derived from the following expression : $Pu^0 = Pu^{res} + F$. Pu^0 is the number of ingoing ^{239}Pu atoms in the pit (about 6 kg or 1.15×10^{25} atoms), Pu^{res} is the unburned plutonium following the test, and F is the number of fissions that occurred (alternatively, the number of original plutonium atoms that were converted to fission fragments through the fission process). Therefore, efficiency is the estimated ratio of post-test fissions and ingoing plutonium.[2] This science, created in the crucible of world war, became and remained the most reliable and accurate method of assessing nuclear detonations throughout the entire United States testing program.

[1]Another Nobel Laureate, I.I. Rabi, won the betting pool for Trinity's yield. Arriving late, he bought the last available number, eighteen kilotons.

[2] Hugh Selby, et.al. A New Yield Assessment for the Trinity Nuclear Test, 75 Years Later.